

Japanese Patent Laid-Open Publication No. Heisei 9-8205

[TITLE OF THE INVENTION]

RESIN-ENCAPSULATED SEMICONDUCTOR DEVICE

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[CLAIMS]

1. A resin-encapsulated semiconductor device using
a lead frame which is shaped in accordance with a two-step
etching process to a body wherein a thickness of inner
10 leads is less than that of the lead frame blank,
comprising:

inner leads having the thickness less than that of the
lead frame blank; and

15 terminal columns integrally connected to the inner
leads and having the same thickness with the lead frame
blank, the terminal columns possessing a column-shaped
configuration which is adapted to be electrically connected
to an external circuit, the terminal columns being disposed
outside of the inner leads in a manner such that they are
20 coupled to the inner leads in a direction orthogonal to the
thickness-wise direction thereof, the terminal columns
having terminal portions arranged on top ends thereof, the
terminal portions being made of solders, etc. and exposed
to the outside beyond a resin encapsulate, each inner lead
25 possessing a rectangular cross-section and having four

surfaces including a first surface, a second surface, a third surface and a fourth surface, the first surface being flushed with one surface of a remaining portion of the inner lead having the same thickness with the lead frame blank while being opposed to the second surface, and each of the third and fourth surfaces having a concave shape depressed toward the inside of the inner lead.

2. A resin-encapsulated semiconductor device using a lead frame which is shaped in accordance with a two-step etching process to a body wherein a thickness of inner leads is less than that of the lead frame blank, comprising:

inner leads having the thickness less than that of the lead frame blank; and

terminal columns integrally connected to the inner leads and having the same thickness with the lead frame blank, the terminal columns possessing a column-shaped configuration which is adapted to be electrically connected to an external circuit, the terminal columns being disposed outside of the inner leads in a manner such that they are coupled to the inner leads in a direction orthogonal to the thickness-wise direction thereof, portions of top ends of the terminal columns being exposed to the outside beyond a resin encapsulate, each inner lead possessing a rectangular

cross-section and having four surfaces including a first surface, a second surface, a third surface and a fourth surface, the first surface being flushed with one surface of a remaining portion of the inner lead having the same thickness with the lead frame blank while being opposed to the second surface, and each of the third and fourth surfaces having a concave shape depressed toward the inside of the inner lead.

3. The resin-encapsulated semiconductor device as claimed in claims 1 or 2, wherein a semiconductor chip is received inward of the inner leads, and electrodes of the semiconductor chip are electrically connected to the inner leads through wires, respectively.

4. The resin-encapsulated semiconductor device as claimed in claim 3, wherein the lead frame has a die pad, and the semiconductor chip is mounted onto the die pad.

5. The resin-encapsulated semiconductor device as claimed in claim 3, wherein the lead frame does not have a die pad, and the semiconductor chip is fastened to the inner leads using a reinforcing fastener tape.

6. The resin-encapsulated semiconductor device as

claimed in claims 1 or 2, wherein the semiconductor chip is fastened by means of insulating adhesive to the second surfaces of the inner leads on one surface thereof on which the electrodes are located, and the electrodes of the semiconductor chip are electrically connected to the first surfaces of the inner leads through wires, respectively.

7. The resin-encapsulated semiconductor device as claimed in claims 1 or 2, wherein the semiconductor chip is fastened to the second surfaces of the inner leads by bumps thereby to be electrically connected to the inner leads.

[DETAILED DESCRIPTION OF THE INVENTION]

[FIELD OF THE INVENTION]

The present invention relates to a resin-encapsulated semiconductor device capable of meeting the requirement for an increase in the number of terminals and resolving problems which are caused in association with position shift and coplanarity of an outer lead.

[DESCRIPTION OF THE PRIOR ART]

FIG. 15(a) shows the configuration of a generally known resin-encapsulated semiconductor device (a plastic lead frame package). The shown resin-encapsulated semiconductor device includes a die pad 1511 having a

semiconductor chip 1520 mounted thereon, outer leads 1513
to be electrically connected to the associated circuits,
inner leads 1512 formed integrally with the outer leads
1513, bonding wires 1530 for electrically connecting the
5 tips of the inner leads 1512 to the bonding pad 1521 of the
semiconductor chip 1520, and a resin 1540 encapsulating the
semiconductor chip 1520 to protect the semiconductor chip
1520 from external stresses and contaminants. This resin-
encapsulated semiconductor device, after mounting the
10 semiconductor chip 1520 on the bonding pad 1521, is
manufactured by encapsulating the semiconductor chip 1520
with the resin. In this resin-encapsulated semiconductor
device, the number of the inner leads 1512 is equal to that
of the bonding pads 1521 of the semiconductor chip 1520.
15 And, FIG. 15(b) shows the configuration of a monolayer lead
frame used as an assembly member of the resin-encapsulated
semiconductor device shown in FIG. 15a. Such a lead frame
includes the bonding pad 1511 for mounting the
semiconductor chip, the inner leads 1512 to be electrically
20 connected to the semiconductor chip, the outer lead 1513
which is integral with the inner leads 1512 and is to be
electrically connected to the associated circuits. This
also includes dam bars 1514 serving as a dam when
encapsulating the semiconductor chip with the resin, and a
25 frame 1515 serving to support the entire lead frame 1510.

Such a lead frame is formed from a highly conductive metal such as a cobalt, 42 alloy (a 42% Ni-Fe alloy), copper-based alloy by a pressing working process or an etching process. FIG. 15(b)(D) is a cross-sectional view taken along the line F1-F2 of FIG. 15(b)(1).

Recently, there has been growing demand for the miniaturization and reduction in thickness of resin-encapsulated semiconductor device employing lead frames like the lead frame (plastic lead frame package) and the increase of the number of terminals of resin-encapsulated semiconductor package as electronic apparatuses are miniaturized progressively and the degree of the integration of semiconductor device increase progressively. Thus, recent resin-encapsulated semiconductor package, particularly quad plate package (QFPs) and thin quad flat packages (TQFPs) have each a greatly increased number of pins.

Lead frames having inner leads arranged at small pitches among lead frames for semiconductor packages are fabricated by a photolithographic etching process, while lead frames having inner leads arranged at comparatively large pitches among lead frames for semiconductor packages are fabricated by press working. However, lead frames having a large number of fine inner leads to be used for forming semiconductor packages having a large number of

pins are fabricated by subjecting a blank of a thickness on the order of 0.25 mm to an etching process, not a press working.

5 The etching process for forming a lead frame having fine inner leads will be described hereinafter with reference to FIG. 14. First, a copper alloy or 42 alloy thin sheet of a thickness on the order of 0.25 mm (a lead frame blank 1410) is cleaned perfectly (FIG. 14(a)). Then, a photoresist, such as a water-soluble casein photoresist containing potassium dichromate as a sensitive agent, is spread in photoresist films 1420 over the major surfaces of the thin film as shown in FIG. 14(b).

10 Then, the photoresist films are exposed, through a mask of a predetermined pattern, to light emitted by a high-pressure mercury lamp, and the thin sheet is immersed in a developer for development to form a patterned photoresist film 1430 as shown in FIG. 14(c). Then, the thin sheet is subjected, when need be, to a hardening process, a washing process and such, and then an etchant containing ferric chloride as a principal component is sprayed against the thin sheet 1410 to etch through portions of the thin sheet 1410 not coated with the patterned photoresist films 1020 so that inner leads of predetermined sizes and shapes are formed as shown in FIG. 14(d).

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Then, the patterned resist films are removed, the patterned thin sheet 1410 is washed to complete a lead frame having the inner leads of desired shapes as shown in FIG. 14(e). Predetermined areas of the lead frame thus
5 formed by the etching process are silver-plated. After being washed and dried, an adhesive polyimide tape is stuck to the inner leads for fixation, predetermined tab bars are bent, when need be, and the die pad depressed. In the etching process, the etchant etches the thin sheet in both
10 the direction of the thickness and directions perpendicular to the thickness, which limits the miniaturization of inner lead pitches of lead frames. Since the thin sheet is etched from both the major surfaces as shown in FIG. 14 during the etching process, it is said, when the lead frame
15 has a line-and-space shape, that the smallest possible intervals between the lines are in the range of 50 to 100% of the thickness of the thin sheet. From the viewpoint of forming the outer lead having a sufficient strength, generally, the thickness of the thin sheet must be about
20 0.125 mm or above. Furthermore, the width of the inner leads must be in the range of 70 to 80 μ m for successful wire bonding. When the etching process as illustrated in FIG. 14 is employed in fabricating a lead frame, a thin sheet of a small thickness in the range of 0.125 to 0.15 mm
25 is used and inner leads are formed by etching so that the

fine tips thereof are arranged at a pitch of about 0.1 mm.

However, recent miniature resin-encapsulated semiconductor package requires inner leads arranged
5 pitches in the range of 0.13 to 0.15 mm, far smaller than 0.165 mm. When a lead frame is fabricated by processing thin sheet of a reduced thickness, the strength of the outer leads of such a lead frame is not large enough
10 to withstand external forces that may be applied thereto in the subsequent processes including an assembling process and a chip mounting process. Accordingly, there is a limit to the reduction of the thickness of the thin sheet to enable the fabrication of a minute lead frame having fine leads arranged at very small pitches by etching.

15 An etching method previously proposed to overcome such difficulties subjects a thin sheet to an etching process to form a lead frame after reducing the thickness of portions of the thin sheet corresponding to the inner leads of the lead frame by half etching or pressing to form
20 the fine inner leads by etching without reducing the strength of the outer leads. However, problems arise in accuracy in the subsequent processes when the lead frame is formed by etching after reducing the thickness of the portions corresponding to the inner leads by pressing; for
25 example, the smoothness of the surface of the plated areas

is unsatisfactory, the inner leads cannot be formed in a flatness and a dimensional accuracy required to clamp the lead frame accurately for bonding and molding, and a platemaking process must be repeated twice making the lead fabricating process intricate. It is also necessary to repeat a platemaking process twice when the thickness of the portions of the thin sheet corresponding to the inner leads is reduced by half etching before subjecting the thin sheet to an etching process for forming the lead frame, which also makes the lead frame fabricating process intricate. Thus, this previously proposed etching method has not yet been applied to practical lead frame fabricating processes.

(SUBJECT MATTERS TO BE SOLVED BY THE INVENTION)

On the other hand, because a pitch among inner leads is made narrow as the number of terminals is increased, it is considered important to know whether a problem is caused or not in association with position shift or coplanarity of an outer lead when implementing a chip mounting process. Accordingly, the present invention has been made in an effort to solve the problems occurring in the related art, and an object of the present invention is to provide a resin-encapsulated semiconductor device capable of meeting the requirement for an increase in the number of terminals

and resolving problems which are caused in association with position shift and coplanarity of an outer lead.

[MEANS FOR SOLVING THE SUBJECT MATTERS:]

5 According to one aspect of the present invention, there is provided a resin-encapsulated semiconductor device using a lead frame which is shaped in accordance with a two-step etching process to a body wherein a thickness of inner leads is less than that of the lead frame blank, comprising: inner leads having the thickness less than that of the lead frame blank; and terminal columns electrically connected to the inner leads and having the same thickness as with the lead frame blank, the terminal columns possessing a column-shaped configuration which is adapted to be electrically connected to an external circuit, the terminal columns being disposed outside of the inner leads in a manner such that they are coupled to the inner leads in a direction orthogonal to the thickness-wise direction thereof, the terminal columns having terminal portions arranged on top ends thereof, the terminal portions being made of solders, etc. and exposed to the outside beyond the resin encapsulate, outer surfaces of the terminal columns also being exposed to the outside beyond the resin encapsulate, each inner lead possessing a rectangular cross-section and having four surfaces including a

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surface, a second surface, a third surface and a fourth surface, the first surface being flushed with one surface of a remaining portion of the inner lead having the same thickness with the lead frame blank while being opposed to the second surface, and each of the third and fourth surfaces having a concave shape depressed toward the first surface of the inner lead.

According to another aspect of the present invention there is provided a resin-encapsulated semiconductor device using a lead frame which is shaped in accordance with a two-step etching process to a body wherein a thickness of inner leads is less than that of the lead frame blank comprising: inner leads having the thickness less than that of the lead frame blank; and terminal columns integrally connected to the inner leads and having the same thickness with the lead frame blank, the terminal columns possessing a column-shaped configuration which is adapted to be electrically connected to an external circuit, the terminal columns being disposed outside of the inner leads in a manner such that they are coupled to the inner leads in a direction orthogonal to the thickness-wise direction thereof, portions of top ends of the terminal columns being exposed to the outside beyond a resin encapsulate, outer surfaces of the terminal columns also being exposed to the outside beyond the resin encapsulate, each inner lead

possessing a rectangular cross-section and having four surfaces including a first surface, a second surface, a third surface and a fourth surface, the first surface being flushed with one surface of a remaining portion of the inner lead having the same thickness with the lead frame blank while being opposed to the second surface, and each of the third and fourth surfaces having a concave shape depressed toward the inside of the inner lead.

According to another aspect of the present invention, a semiconductor chip is received inward of the inner leads, and electrodes (pads) of the semiconductor chip are electrically connected to the inner leads through wires, respectively. According to another aspect of the present invention, the lead frame has a die pad, and the semiconductor chip is mounted onto the die pad. According to another aspect of the present invention, the lead frame does not have a die pad, and the semiconductor chip is fastened to the inner leads using a reinforcing fastener tape. According to still another aspect of the present invention, the semiconductor chip is fastened by means of insulating adhesive to the second surfaces of the inner leads on one surface thereof on which the electrodes are located, and the electrodes of the semiconductor chip are electrically connected to the first surfaces of the inner leads through wires, respectively. According to yet still

another aspect of the present invention, the semiconductor chip is fastened to the second surfaces of the inner leads by bumps thereby to be electrically connected to the inner leads. In the above descriptions, in the case that the terminal columns have terminal portions which are arranged on top ends of the terminal columns, with the terminal portions made of solders, etc. and exposed to the outside beyond the resin encapsulate, while it is the norm that the terminal portions comprising the solders, etc. are exposed to the outside beyond the resin encapsulate, it is not necessarily required for the terminal portions to be projected beyond the resin encapsulate. Moreover, while it is possible to use the outside surfaces of the terminal columns while they are not encapsulated by the resin encapsulate and they are exposed to the outside, the outside surfaces of the terminal columns which are not encapsulated by the resin encapsulate, can be covered by a protective frame using adhesive, etc.

20 (WORKING FUNCTIONS)

The resin-encapsulated semiconductor device in accordance with the present invention can meet a demand for an increase in the number of terminals. At the same time, in the resin-encapsulated semiconductor device, because the forming process of the outer leads as in the case of using

a mono-layered lead frame shown in FIG. 13(b) is not required, it is possible to provide a semiconductor device in which no problems are caused in association with position shift and coplanarity of the outer leads. More particularly, the use of a multi-pinned lead frame shaped in a manner that inner leads have a thickness less than that of the lead frame blank by a two-step etching process, that is, the inner leads are arranged at a fine pitch, can meet a demand for an increase in the pin number of the semiconductor device. Furthermore, by using the lead frame which is fabricated by a two-step etching process as will be described later with reference to FIG. 1, the second surface of each inner lead has coplanarity, and is excellent in wire-bonding property. In addition, since the first surface of the inner lead is also a flat surface and the third and fourth surfaces are depressed toward the inside of the inner lead, the inner leads are stable and coplanarity width upon wire bonding process can be enlarged.

[EMBODIMENTS]

Embodiments of the resin-encapsulated semiconductor device in accordance with the present invention will now be described with reference to the attached drawings. First, a resin-encapsulated semiconductor device in accordance

With a first embodiment of the present invention described hereinafter with reference to FIGs. 1. FIG. 1(a) is a cross-sectional view of the encapsulated semiconductor device according to the embodiment of the present invention. FIG. 1(b) is a sectional view of an inner lead taken along the line of FIG. 1(a), and FIG. 1(c) is a cross-sectional view of a terminal column taken along the line B1-B2 of FIG. 1. Moreover, FIG. 2(a) is a perspective view of the encapsulated semiconductor device according to the embodiment of the present invention, FIG. 2(b) is a view of the resin-encapsulated semiconductor device of FIG. 2(a), and FIG. 2(c) is a bottom view of the encapsulated semiconductor device of FIG. 2(a). In FIGs. 1 and 2, a drawing reference numeral 100 represents a resin-encapsulated semiconductor device, 110 a semiconductor chip, 111 electrodes (pads), 120 wires, 130 a lead, 131 inner leads, 131Aa a first surface, 131Ab a second surface, 131Ac a third surface, 131Ad a fourth surface, 133A terminal columns, 133B terminal portions, 133C top surfaces, 133D a top surface, 135 a die pad, and 140 a resin encapsulate.

In the resin-encapsulated semiconductor device according to the first embodiment, as shown in FIG. 1, the semiconductor chip 110 is placed inward of the

leads 131. As can be readily seen from FIG. 1(a), the semiconductor chip 110 is mounted on the die pad 133 at the surface thereof which is opposed to the other surface thereof where the electrodes pads 111 of the semiconductor chip 110 are arranged. Each electrode pad 111 is electrically connected to the second surface 131a of the inner lead 131 through the wire 120. The electrical connection between the resin-encapsulated semiconductor device 100 of this embodiment and an external circuit is achieved by mounting the resin-encapsulated semiconductor device 100 via the terminal portions 133A each being made of a semi-spherical solder, on a printed circuit substrate, with the terminal portions 133A located on the top surfaces 133S of the terminal columns 133, respectively. In the resin-encapsulated semiconductor device of the first embodiment of the present invention, it is not necessarily required to provide a protective frame 190, and instead, a structure, as shown in FIG. 1(d), in which no protective frame is used can be adopted.

The lead frame 130 used in the semiconductor device 100 according to the first embodiment is made of a 42% nickel-iron alloy. Therefore, the lead frame 130A which has a contour as shown in FIG. 9(a) and is shaped by an etching process, is used as the lead frame 130. The lead frame 130 has inner leads 131 which are shaped to have a

thickness less than that of the terminal columns 133 or other portions. Dam bars 136 serve as a dam when encapsulating the semiconductor chip 110 with a resin. Moreover, although the lead frame 130A which is processed by etching to have the contour as shown in FIG. 9A is used in this embodiment, the lead frame is not limited to such a contour because portions except the inner leads 131 and the terminal columns 133 are not necessary. The inner leads 131 have a thickness of 40 μ m whereas the portions of the lead frame 130 other than the inner leads 131 have a thickness of 0.15 mm which corresponds to the thickness of the lead frame blank. The other portions of the lead frame 130 except the inner leads 131 may not have the thickness of 0.15 mm, but have a thickness of 0.125 mm-0.50 mm which is thinner. The tips of the inner leads 131 have a small pitch of 0.12 mm so as to achieve an increase in the number of terminals for semiconductor devices. The second face 131Ab of the inner lead 131 has a substantially flat profile so as to allow an easy wire bonding thereon. Also, as shown in FIG. 1(b), because the third and fourth faces 131Ac and 131Ad have a concave shape which is depressed toward the inside of the associated inner lead, a high strength can be obtained even though the second face (wire bonding surface) 131Ab is narrowed.

In the present embodiment, since twisting does not

occur in the inner leads 131 irrespective of whether the inner leads 131 is long or not. The inner leads having the contour, as shown in FIG. 9(a), in which the tips of the inner leads 131 are separated one from another, are prepared by the etching process, and the inner leads are resin-encapsulated after mounting the semiconductor chip thereon as will be described later. However, where the inner leads 131 are long in their length and have a tendency for the generation of twisting therein, it is impossible to fabricate the lead frame by etching to have the contour as shown in FIG. 9(a). Therefore, after etching the lead frame in a state where the tips of the inner leads are fixed to the connecting portion 131B as shown in FIG. 9(c)(1), the inner leads 131 are fixed with the reinforcing tape 160 as shown in FIG. 9(c)(2). Then, the connecting portions 131B which are not necessary in the fabrication of the resin-encapsulated semiconductor device are removed by a press as shown in FIG. 9(c)(3), and a semiconductor device is then mounted on the lead frame.

Hereinafter, a method for the fabrication of the resin-encapsulated semiconductor device will now be described with reference to FIG. 8. First, the lead frame 130A, as shown in FIG. 9(a), which is shaped by the etching process as will be described later, is prepared such that the second surfaces 131Ab of the inner leads 131 are

directed upward (FIG. 8(a)).

Then, the semiconductor chip 110 is mounted onto the die pad 135 such that the surfaces of the semiconductor chip 110 on which the electrodes 111 are arranged, are directed upward (FIG. 8(b)).

Next, after the semiconductor chip 110 is fastened onto the die pad 135, the electrodes 111 of the semiconductor chip 110 and the second surfaces 131ab of the inner leads 131 are bonded with each other using wires 110 (FIG. 8(c)).

Subsequently, encapsulation is carried out with the conventional resin encapsulate 140. Thereafter, unnecessary portions of the lead frame 130 which are protruded from the resin encapsulate 140 are cut by a press to form terminal columns 133 and also the side surfaces 133B of the terminal columns 133 (FIG. 8(d)).

Then, the dam bars 136, the frame portions 137, etc. of the lead frame 130A as shown in FIG. 9 are removed. Next, the terminal portions 133A each made of the semi-spherical solder are arranged on the outer surface of each terminal column 133 to fabricate a resin-encapsulated semiconductor device (FIG. 8(e)).

Thereafter, the protective frame 180 is arranged by means of adhesive around an entire outer surface of the resultant structure in such a manner that the side surfaces

of the terminal columns 133 are covered thereby (FIG. 6(f)). At this time, the protective frame 180 functions to reinforce the semiconductor device. In other words, the protective frame 180 serves to prevent moisture from leaking into a gap between the resin encapsulate and the terminal columns due to the fact that the side surfaces of the terminal columns are exposed to the outside, whereby a crack is not formed in the semiconductor device and the breakage of the semiconductor device is avoided. However, persons skilled in the art will readily appreciate that it is not necessarily required to provide the protective frame 180. Also, when such an encapsulating process by the resin is carried out using a desired mold, the encapsulating process is implemented in a state wherein the outer side surfaces of the terminal columns of the lead frame are somewhat protruded out of the resin encapsulate.

A method for etching the lead frame of the first embodiment will now be described in conjunction with the attached drawings. FIG. 11 is of cross-sectional views respectively illustrating sequential steps of the etching process for the lead frame of the first embodiment. In particular, the cross-sectional views of FIG. 1 correspond to a cross section taken along the line D1-D2 of FIG. 9(a). In FIG. 11, the reference numeral 1110 denotes a lead frame blank, 1120A and 1120B resist patterns, 1130 first opening,

1140 second openings, 1150 first concave portions, 1160 second concave portions, 1170 flat surfaces, and 1180 an etch-resistant layer. First, a water-soluble casein resist using potassium dichromate as a sensitive agent is coated
5 over both surfaces of the lead frame blank 1110 made of a 42% nickel-iron alloy and having a thickness of about 0.15 mm. Using desired pattern plates, the resist films are patterned to form resist patterns 1120A and 1120B having first opening 1130 and second openings 1140, respectively
10 (FIG. 11(a)).

The first opening 1130 is adapted to etch the lead frame blank 1110 to have a flat etched bottom surface to a thickness smaller than that of the lead frame blank 1110 in a subsequent process. The second openings 1140 are adapted
15 to form desired shapes of tips of inner leads. Although the first opening 1130 includes at least an area forming the tips of the inner leads 1110, a topology generated by partially thinned portion by etching in a subsequent process can cause hindrance in a taping process or a
20 clamping process for fixing the lead frame. Thus, an area to be etched needs to be large without being limited to fine portions of the tips of the inner leads. Thereafter, both surfaces of the lead frame blank 1110 formed with the resist patterns are etched using a 48 Be' ferric chlorid
25 solution of a temperature of 57°C at a spray pressure of

2.5 kg/cm². The etching process is terminated at the point of time when first recesses 1150 etched to have a flat etched bottom surface have a depth h corresponding to $1/3$ of the thickness of the lead frame blank (FIG. 11 a).

5 Although both surfaces of the lead frame blank 1110 are simultaneously etched in the primary etching process, it is not necessary to simultaneously etch both surfaces of the lead frame blank 1110. The reason why both surfaces of the lead frame blank 1110 are simultaneously etched, as in
10 this embodiment, is to reduce the etching time taken in a secondary etching process as will be described later. The total time taken for the primary and secondary etching processes is less than that taken in the case of etching of only one surface of the lead frame blank on which the resist pattern 1120B is formed. Subsequently, the surface
15 provided with the first recesses 1150 respectively etched at the first opening 1130 is entirely coated with an etch-resistant hot-melt wax (acidic wax type MR-WB6, The Inctec Inc.) by a die coater to form an etch-resistant layer 1180 so as to fill up the first recesses 1150 and to
20 cover the resist pattern 1120A (FIG. 11(c)).

It is not necessary to coat the etch-resistant layer 1180 over the entire portion of the surface provided with the resist pattern 1120A. However, it is preferred that
25 the etch-resistant layer 1180 be coated over the entire

portion of the surface formed with the first recess
and first opening 1130, as shown in FIG. 11(c), beca
is difficult to coat the etch-resistant layer 1180 o
the surface portion including the first recesses
5 Although the etch-resistant layer 1180 wax employed i
embodiment is an alkali-soluble wax, any suitabl
resistant to the etching action of the etchant solution
remaining somewhat soft during etching may be used.
for forming the etch-resistant layer 1180 is not limit
10 the above-mentioned wax, but may be a wax of a UV-se
type. Since each first recess 1130 etched by the pr
etching process at the surface formed with the pa
adapted to form a desired shape of the inner lead t
filled up with the etch-resistant layer 1180, it is
15 further etched in the following secondary etching pro
The etch-resistant layer 1180 also enhances the mechan
strength of the lead frame blank for the second etc
process, thereby enabling the second etching process to
conducted while keeping a high accuracy. It is
20 possible to enable a second etchant solution to be spr
at an increased spraying pressure, for example, 2.5 kg
or above, in the secondary etching process. The increa
spraying pressure promotes the progress of etching in
direction of the thickness of the lead frame blank in
25 secondary etching process. Then, the lead frame blank

subjected to a secondary etching process. In this
secondary etching process, the lead frame blank 1110 is
etched at its surface formed with first recesses 1130
having a flat etched bottom surface, to completely
5 perforate the second recesses 1160, thereby forming the
tips of inner leads 131A (FIG. 11C)).

The bottom surface 1170 of each recess formed by the
primary etching process is flat. However, both side
surfaces of each recess positioned at opposite sides of the
10 bottom surface 1170 have a concave shape depressed toward
the inside of the inner lead. Then, the lead frame blank
is cleaned. After completion of the cleaning process, the
etch-resistant layer 1180, and resist films (resist
patterns 1120A and 1120B) are sequentially removed. Thus,
15 a lead frame 130A having a structure of FIG. 9(a) is
obtained in which tips of the inner leads 131A are arranged
at a fine pitch. The removal of the etch-resistant layer
1180 and resist films (resist patterns 1120A and 1120B) is
achieved using a sodium hydroxide solution serving to
20 dissolve them.

The processes for manufacturing the lead frame as
shown in FIG. 11, is to form by means of etching the lead
frame having the tips of the inner leads used in this
embodiment of the present invention, which have a thickness
25 less than that of the lead frame. Especially, the first

surfaces 131Aa of the tips of the inner leads as shown in FIG. 1, are flushed with one surfaces of remaining portions of the inner leads having the same thickness with the lead frame while being opposed to the second surfaces 131Ab, and the third and fourth surfaces are formed to have a concave shape which is depressed toward the inside of the inner leads. Where a semiconductor chip is mounted on the second surfaces 131Ab of the inner leads by means of bumps for an electrical connection therebetween, as in a semiconductor device according to a third embodiment as will be described hereinafter, an increased tolerance for the connection by bumps is obtained when the second surface 131Ab has a concave shape depressed toward the inside of the inner lead. To this end, an etching method shown in FIG. 12 is adopted in this case. The etching method shown in FIG. 12 is the same as that of FIG. 11 in association with its primary etching process. After completion of the primary etching process, the etching method is conducted in a manner different from that of the etching method of FIG. 11 in that the second etching process is conducted at the side of the first recesses 1150 after filling up the second recesses 1160 by the etch-resist layer 1180, thereby completely perforating the second recesses 1160. At this time, by implementing the primary etching process, etching at the side of the second openings 1140 is performed in a

sufficient manner. The cross section of each inner lead, including its tip, formed in accordance with the etching method of FIG. 12, has a concave shape depressed toward the inside of the inner lead at the second surface 131Ab, as shown in FIG. 6(b).

The etching method in which the etching process is conducted at two separate steps, respectively, as in that of FIGs. 11 and 12, is generally called a "two-step etching method". This etching method is advantageous in that a desired fineness can be obtained. The etching method used to fabricate the lead frame 130A of the first embodiment shown in FIG. 9 involves the two-step etching method and the method for forming a desired shape of each lead frame portion while reducing the thickness of each pattern formed. In particular, the etching method makes it possible to achieve a desired fineness. In accordance with the method illustrated in FIGs. 11 and 12, the fineness of the tip of each inner lead 131A formed by this method is dependent on the shape of the second recesses 1160 and the thickness t of the inner lead tip which is finally obtained. For example, where the blank has a thickness t reduced to 50 μ m, the inner leads can have a fineness corresponding to a lead width W_1 of 100 μ m and a tip pitch p of 0.15 mm, as shown in FIG. 11(e). In the case of using a small blank thickness t of about 30 μ m and a lead

width W_1 of 70 μm , it is possible to form inner leads having a fineness corresponding to an inner lead pitch p of 0.12 mm. Of course, it may be possible to form inner leads having a further reduced tip pitch by adjusting the blank thickness t and the lead width W_1 . That is to say, an inner lead tip pitch p up to 0.08 mm, a blank thickness up to 25 μm , and a lead width W_1 up to 40 μm can be obtained.

In the case where twisting of the inner leads does not occur in the fabricating process, as in the case where the inner leads are short in their length, a lead frame illustrated in FIG. 9(a) can be directly obtained. However, where the inner leads are long in length as compared to those of the first embodiment, the inner leads have tendency for the generation of twisting. Thus, in this case, the lead frame is obtained by etching in a state where the tips of the inner leads are bound to each other by a connecting member 131B as shown in FIG. 9(c)(1). Then, the connecting member 131B which is not necessary for the fabrication of a semiconductor package is cut off by means of a press to obtain a lead frame shaped as shown in FIG. 9(a).

Moreover, as described above, where unnecessary portions in a structure shown in FIG. 9(c)(1) are cut to obtain the lead frame having the contour shown in FIG.

9(a), a reinforcing tape 160 (a polyimide tape) is generally used, as shown in FIG. 9(c)(A). While the connecting member 131B is cut off by means of a press to obtain the contour shown in FIG. 9(c)(D), a semiconductor device is mounted on the lead frame still having the reinforcing tape attached thereon. Also, the mounted semiconductor device is encapsulated with a resin in a condition where the lead frame still has the tape. The line E11-E12 illustrates a cut portion.

10 The tip of the inner lead 131 of the lead frame used in the semiconductor device of this first embodiment has a cross-sectional shape as shown in FIG. 13(1)(a). The tip 131A has an etched flat surface (second surface) 131Ab which is substantially flat and therefore has a width W1 slightly greater than the width W2 of an opposite surface. 15 The widths W1 and W2 (about 1000 μ m) are more than the width W at the central portion of the tips when viewed in the direction of the inner lead thickness. Thus, the tip of the inner lead has a cross-sectional shape having opposite wide surfaces. To this end, although either of 20 the opposite surfaces of the tip 131A can be easily electrically connected to a semiconductor device (not shown) by a wire 120A or 120B, this embodiment illustrates the use of the etched flat surface for wire-bonding as 25 shown in FIG. 13(D)(a). In FIG. 13, a reference numeral

131Ab depicts an etched flat surface, 131Aa a surface of a
lead frame blank, and 121A and 121B, respectively, a plated
portion. In the case of FIG. 13(D)(a), there has
particularly excellent in wire-bonding property, because
5 the etched flat surface does not have roughness. FIG.
13(A) shows that the tip 1331B of the inner lead of the
lead frame fabricated according to the process illustrated
in FIG. 14 is wire-bonded to a semiconductor device. In
this case, however, both the opposite surfaces of the tip
10 1331B of the inner lead are flat, but have a width smaller
than that in a direction of the inner lead thickness. In
addition to this, as both the opposite surfaces of the tip
1331B is formed of surfaces of the lead frame blank, these
surfaces have an inferior wire-bonding property as compared
15 to that of the etched flat surface of this first
embodiment. FIG. 13(=) shows that the inner lead tip
1331C or 1331D, obtained by thinning in its thickness by a
means of a press (coining) and then by etching, is wire-
bonded to a semiconductor device (not shown). In this
20 case, however, a pressed surface of the inner lead tip is
not flat as shown FIG. 13(=). Thus, the wire-bonding on
either of the opposite surfaces as shown in FIG. 13(=)(a)
or FIG. 13(=)(b) often results in an insufficient wire-
bonding stability and a problematic quality. The drawing
25 reference numeral 1331Ab represents a coining surface.

A modified example of the resin-encapsulated semiconductor device in accordance with the first embodiment of the present invention will be described hereinafter. FIGs. 3(a) through 3(e) are cross-sectional views of the modified example of the resin-encapsulated semiconductor device in accordance with the first embodiment of the present invention. The semiconductor device of the modified example as shown in FIG. 3(a), is different from that of the first embodiment in that a position of the die pad 135 is changed, that is, the die pad 135 is exposed to the outside. By the fact that the die pad 135 is exposed to the outside, the heat dissipation property is improved as compared to the first embodiment. Also, in the semiconductor device of the modified example as shown in FIG. 3(b), because the die pad 135 is exposed to the outside, the heat dissipation property is improved as compared to the first embodiment. Unlike the first embodiment or the modified example as shown in FIG. 3(a), in the present modified example as shown in FIG. 3(b), because a direction of the semiconductor device 110 is changed, the first surfaces of the lead frame are established as the wire bonding surfaces. The modified examples as shown in FIGs. 3(c), 3(d) and 3(e), illustrate semiconductor devices which are obtained by modifying the semiconductor devices of the first embodiment, the modified

example as shown in FIG. 3(a) and the modified example as shown in FIG. 3(b), wherein the semi-spherical solders are not used, and instead, the top surfaces of the terminal columns are directly used as the terminal portions, whereby an entire manufacturing procedure can be simplified.

Next, a resin-encapsulated semiconductor device in accordance with a second embodiment of the present invention will be described. FIG. 4(a) is a cross-sectional view of the resin-encapsulated semiconductor device in accordance with the second embodiment of the present invention, FIG. 4(b) is a cross-sectional view illustrating inner leads, taken along the line A3-A4 of FIG. 4(a), and FIG. 4(c) is a cross-sectional view illustrating a terminal column, taken along the line B3-B4 of FIG. 4(a). Because an outer appearance of the semiconductor device of the second embodiment is substantially the same as that of the first embodiment, it is not illustrated in the drawings. In FIG. 3, the drawing reference numeral 200 represents a semiconductor device, 210 a semiconductor chip, 211 electrodes (pads), 220 wires, 230 a lead frame, 231 inner leads, 231Ab a second surface, 231Ac a third surface, 231Ad a fourth surface, 233 terminal columns, 233A terminal portions, 233B side surfaces, 233S top surfaces, 240 a resin encapsulate, and 270 a reinforcing fastener tape. In the semiconductor device of

this second embodiment, the lead frame 230 does not have a die pad, the semiconductor chip 210 is fastened to the inner leads 231 by the reinforcing fastener tape 270, and the semiconductor chip 210 is electrically connected at its electrodes (pads) 211 to the second surfaces 231Ab of the inner leads 231 by wires 220. Also, in the case of this second embodiment, similarly to the first embodiment, the electrical connection between the resin-encapsulated semiconductor device 200 of this embodiment and an external circuit is achieved by mounting the resin-encapsulated semiconductor device 200 via the terminal portions 233A each being made of a semi-spherical solder, on a printed circuit substrate, with the terminal portions 233A located on the top surfaces 233S of the terminal columns 233, respectively.

In addition, the semiconductor device of this second embodiment does not have a die pad as shown in FIGs. 10(a) and 10(b). The manufacturing method of the semiconductor device of this embodiment using the lead frame 230A which is shaped by the etching process is substantially the same as that of the first embodiment except that, while in the case of the first embodiment, the wire bonding process and resin encapsulating process are performed in a state wherein the semiconductor chip is fastened to the inner leads, in the case of the second embodiment, the wire

bonding process and resin encapsulating process are performed in a state wherein the semiconductor chip 210 is fastened together with the inner leads 231 by the reinforcing fastener tape 270. Also, the cutting process for the unnecessary portions and the terminal portion forming process after resin encapsulating process are implemented in the same way as the first embodiment. The lead frame 230 as shown in FIG. 10(a) is obtained in the same manner by which the lead frame 130A as shown in FIG. 9(a) is obtained. In other words, by cutting the resultant structure obtained after etching the structure as shown in FIG. 10(c)(1), the contour as shown in FIG. 10(a) is obtained. At this time, the conventional reinforcing fastener tape 260 (the polyimide tape) as shown in FIG. 10(c)(2), which performs a reinforcing function is used.

FIG. 5(a) through 5(c) are cross-sectional views illustrating modified examples of the semiconductor device of the second embodiment. The semiconductor device as shown in FIG. 5(a) is different from the semiconductor device of the second embodiment, in that the surface of the semiconductor chip thereof which has the electrodes is directed downward. The modified examples as shown in FIGS. 5(b) and 5(c), illustrate semiconductor devices which are obtained by modifying the semiconductor devices of the second embodiment and the modified example as shown in FIG.

5(a), wherein the semi-spherical solders are not used, and instead, the top surfaces of the terminal columns are directly used as the terminal portions. In these examples, because a protective frame is not used and the side surfaces 333B of the terminal columns 333 are exposed to the outside, a checking operation by a test, etc. can be easily performed.

Hereinafter, a resin-encapsulated semiconductor device in accordance with a third embodiment of the present invention will be described. FIG. 6(a) is a cross-sectional view of the resin-encapsulated semiconductor device of the third embodiment, FIG. 6(b) is a cross-sectional view illustrating inner leads, taken along the line A5-A6 of FIG. 6(a), and FIG. 6(c) is a cross-sectional view illustrating a terminal column, taken along the line B5-B6 of FIG. 6(b). Because an outer appearance of the semiconductor device of the this third embodiment is substantially the same as that of the first embodiment, it is not illustrated in the drawings. In FIG. 6, the drawing reference numeral 300 represents a semiconductor device, 310 a semiconductor chip, 312 bumps, 330 a lead frame, 331 inner leads, 331Aa a first surface, 331Ab a second surface, 331Ac a third surface, 331Ad a fourth surface, 333 terminal columns, 333A terminal portions, 333B side surfaces, 333S top surfaces, 340 a resin encapsulate, and 350 a

reinforcing fastener tape. In the semiconductor device of this third embodiment, the semiconductor chip 310 is fastened to the second surfaces 331Ab of the inner leads 331 by the bumps 311 thereby to be electrically connected to the second surfaces 331Ab. The lead frame 330 has a contour as shown in FIGs. 10(a) and 10(b), which is formed by the etching process of FIG. 11. As shown in FIG. 13(1)(b), both widths W1A and W2A (about 100 μ m) at top and bottom ends of the inner leads 331 are larger than a width WA at a center portion in a thickness-wise direction. Due to the fact that the second surfaces 331Ab of the inner leads 331 is depressed toward the inside of the inner leads and the first surfaces 331Aa are flat, a desired fineness can be obtained. Also, when the second surfaces 331Ab of the inner leads 331 are electrically connected to the semiconductor chip via bumps, easy connection can be accomplished as shown in FIG. 13(D)(b). Further, in the case of this third embodiment, as in the case of the first and second embodiments, the electrical connection between the resin-encapsulated semiconductor device 300 of this embodiment and an external circuit is achieved by mounting the resin-encapsulated semiconductor device 300 via the terminal portions 333A each being made of a semi-spherical solder, on a printed circuit substrate, with the terminal portions 333A located on the top surfaces of the terminal

columns 333, respectively.

In addition, unlike the semiconductor device of the first embodiment, the semiconductor device of this third embodiment uses a lead frame which is shaped by the etching process as shown in FIG. 12. However, the manufacturing method of the semiconductor device of this embodiment is substantially the same as that of the first embodiment except that, while in the case of the first embodiment, the wire bonding process and resin encapsulating process are performed in a state wherein the semiconductor chip is fastened to the inner leads, in the case of this third embodiment, the wire bonding process and resin encapsulating process are performed in a state wherein the semiconductor chip 310 is fastened to the inner leads 331 via the bumps. Also, the cutting process for the unnecessary portions and the terminal portion forming process after resin encapsulating process are implemented in the same way as the first embodiment.

FIG. 6(d) is a cross-sectional view illustrating a modified example of the semiconductor device in accordance with the third embodiment of the present invention. In the modified example of the semiconductor device as shown in FIG. 6(d), the terminal portions each comprising the semi-spherical solder are not provided, and the top surfaces of the terminal columns are directly used as the terminal

portions. Because the protective frame is not used and the side surfaces 333B of the terminal columns 333 are exposed to the outside, a checking operation by a test, etc. can be easily performed.

5 Hereinafter, a resin-encapsulated semiconductor device in accordance with a fourth embodiment of the present invention will be described. FIG. 7(a) is a cross-sectional view of the resin-encapsulated semiconductor device of the fourth embodiment, FIG. 7(b) is a cross-sectional view illustrating inner leads, taken along the line A7-A8 of FIG. 7(a), and FIG. 7(c) is a cross-sectional view illustrating a terminal column, taken along the line 10 B7-B8 of FIG. 7(b). Because an outer appearance of the semiconductor device of the this fourth embodiment is substantially the same as that of the first embodiment, it is not illustrated in the drawings. In FIG. 7, the drawing reference numeral 400 represents a semiconductor device, 15 410 a semiconductor chip, 411 pads, 430 a lead frame, 431 inner leads, 431Aa a first surface, 431Ab a second surface, 431Ac a third surface, 431Ad a fourth surface, 433 terminal columns, 433A terminal portions, 433B side surfaces, 433S top surfaces, 440 a resin encapsulate, and 470 insulating adhesive. In the semiconductor device of this fourth embodiment, one surface of the semiconductor chip 410 on 20 which the pads 411 are disposed is fastened to the second 25

surfaces 431Ab of the inner leads 431 by the insul-
adhesive 470, and the pads 411 and the first surfaces
of the inner leads 431 are electrically connected with
other by wires 420. The semiconductor device of
5 fourth embodiment uses the same lead frame which is use
the third embodiment, which has the contour as shown
FIG. 10(a) and 10(b). Also, in the case of this fourth
embodiment, as in the case of the first and second
embodiments, the electrical connection between the res-
10 encapsulated semiconductor device 400 of this embodiment
and an external circuit is achieved by mounting the res-
encapsulated semiconductor device 400 via the terminal
portions 433A each being made of a semi-spherical solder
on a printed circuit substrate, with the terminal portion
15 433A located on the top surfaces of the terminal columns
433, respectively.

FIG. 7(d) is a cross-sectional view illustrating
modified example of the semiconductor device in accordance
with the fourth embodiment of the present invention. In
20 the modified example of the semiconductor device as shown
in FIG. 7(d), the terminal portions each comprising the
semi-spherical solder are not provided, and the top
surfaces of the terminal columns are directly used as the
terminal portions. Because the protective frame is not
25 used and the side surfaces 433B of the terminal columns 433

are exposed to the outside, a checking operation by a test, etc. can be easily performed.

[EFFECTS OF THE INVENTION]

5 The present invention provides a resin-encapsulated semiconductor device employing the above-mentioned lead frame, which is capable of meeting a demand for the increased terminal number. Furthermore, the resin-encapsulated semiconductor device in accordance with this invention does not require a process of cutting or bending the dam bars as in the case of using a lead frame having outer leads as shown in FIG. 13(b). As a result of this, the resin-encapsulated semiconductor device does not have a problem in that the outer leads are bent, or a problem associated with coplanarity. In addition to these advantages, the resin-encapsulated semiconductor device has a shortened interconnection length as compared to the QTP or the BGA, whereby the semiconductor device can be reduced in a parasitic capacity, and shortened in a transfer delay time.

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59:543 v1

59:543 v1

特開平 9-8205

(14)公開日 平成 9 年 (1997) 1 月 15 日

(51) Int. Cl.

H01L 23/38

23/12

出願記号

特許庁登録番号

F1

H01L 23/38

23/12

特許庁登録番号

審査請求 異議 再審査の請求 F D 全 15 頁

(11)出願番号 特許 7-170490

(12)出願日 平成 7 年 (1995) 6 月 14 日

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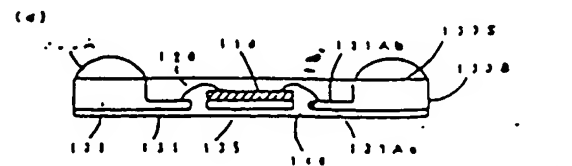
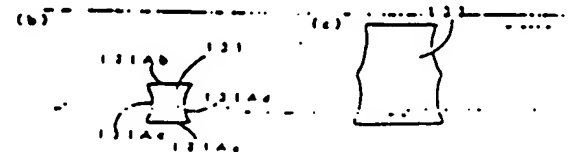
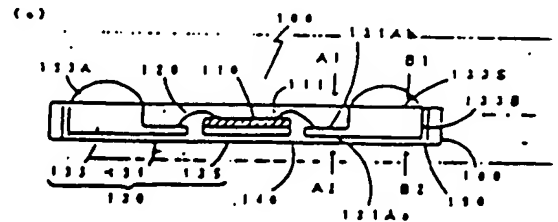
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(17)【発明の名称】 紙質防止型半導体装置

(18)【要約】 (形正書)

【目的】 多素子化に対応でき、且つ、アフターリードの位置ズレや平坦性の向上にも対応できる紙質防止型半導体装置を提供する。

【構成】 一体的に連続したリードフレーム基板と同じ厚さの外部回路層と積層するための凹凸の端子部 133 とを有し、且つ、端子部はインターリードの外側においてインターリードに対して厚み方向に突出して設けられており、端子部の先端面に半導体からなる素子部を露出させ、端子部を防止層 131 から露出させ、端子部の外部側の側面を防止層 131 から露出させており、インターリードは、断面形状が略方形で第 1 面 131Aa、第 2 面 131Ab、第 3 面 131Ac、第 4 面 131Ad の 4 面を有しており、かつ第 1 面はリードフレーム基板と同じ厚さの部分の一方の面と同一平面上にあって第 2 面に向を合っており、第 3 面、第 4 面はインターリードの内側に向を合っており、凹んだ形状に形成されている。



(図 1 の 説 明)

(図 1) 2 段ニッチング加工によりインナーリードの厚さがリードフレーム素材の厚さより厚みになり、形成されたリードフレームを用いた半導体装置であつて、前記リードフレームは、リードフレーム素材より厚みのあるインナーリードと、該インナーリードに一体的に連結したリードフレーム素材と同じ厚さの外部図層とを形成するための凸状の端子部とを有し、且つ、端子部はインナーリードの外周側においてインナーリードに対して厚み方向に突出して設けられており、端子部の先端部に半導体からなる端子部を設け、端子部を封止用樹脂層から露出させ、端子部の外周側の側面を封止用樹脂層から露出させており、インナーリードは、断面形状が矩形で第1面、第2面、第3面、第4面の4面を有しており、かつ第1面はリードフレーム素材と同じ厚さの他の部分の一方の面と同一平面上にあって第2面に向を合っており、第3面、第4面はインナーリードの内側に向かつて凹んだ形状に形成されていることを特徴とする装置封止型半導体装置。

(図 2) 2 段ニッチング加工によりインナーリードの厚さがリードフレーム素材の厚さより厚みになり、加工されたリードフレームを用いた半導体装置であつて、前記リードフレームは、リードフレーム素材より厚みのあるインナーリードと、該インナーリードに一体的に連結したリードフレーム素材と同じ厚さの外部図層とを形成するための凸状の端子部とを有し、且つ、端子部はインナーリードの外周側においてインナーリードに対して厚み方向に突出して設けられており、端子部の先端の一部を封止用樹脂層から露出させて端子部とし、端子部の外周側の側面を封止用樹脂層から露出させており、インナーリードは、断面形状が矩形で第1面、第2面、第3面、第4面の4面を有しており、かつ第1面はリードフレーム素材と同じ厚さの他の部分の一方の面と同一平面上にあって第2面に向を合っており、第3面、第4面はインナーリードの内側に向かつて凹んだ形状に形成されていることを特徴とする装置封止型半導体装置。

(図 3) 図 1 ないし 2 において、半導体素子はインナーリード間に設けられ、半導体素子の電極部はワイヤにてインナーリードと電気的に接続されていることを特徴とする装置封止型半導体装置。

(図 4) 図 3 において、リードフレームはダイパッドを有しており、半導体素子はダイパッド上に搭載され、固定されていることを特徴とする装置封止型半導体装置。

(図 5) 図 3 において、リードフレームはダイパッドを有しないもので、半導体素子はインナーリードとともに高粘度接着剤により固定されていることを特徴とする装置封止型半導体装置。

(図 6) 図 1 ないし 2 において、半導体素子は半導体素子の電極部をインナーリードの第2面

に施したワイヤにより固定されており、該半導体素子の電極部はワイヤによりインナーリードの第1面と電気的に接続されていることを特徴とする装置封止型半導体装置。

(図 7) 図 1 ないし 2 において、半導体素子はバンプによりインナーリードの第2面に固定されて電気的にインナーリードと接続していることを特徴とする装置封止型半導体装置。

(図 8 の 説 明)

(0 0 0 1)

(図 8 の 別 開 示) 本 発 明 に、半導体装置の多ピン化に対応して、且つ、アフターリードの位置ずれ (スニュー) やアフターリードの半導体 (コプラチナチー) の変形を防ぐため、リードフレームを用いた装置封止型半導体装置に於ける。

(0 0 0 2)

(図 8 の 別 開 示) 従来の装置封止型の半導体装置 (プラスチックリードフレームパッケージ) は、一面に図 15 (a) に示されるような構造であり、

半導体素子 1510 を搭載するダイパッド部 1511 と、電極部との電気的接続を行うためのアフターリード部 1513、アフターリード部 1513 に一体となったインナーリード部 1512、該インナーリード部 1512 の先端部と半導体素子 1520 の電極パッド 1521 とを電気的に接続するためのワイヤ 1530、半導体素子 1520 を封止して外部からの応力、汚染から守る樹脂 1540 からなっており、半導体素子 1520 をリードフレームのダイパッド 1511 部に搭載した後、

に、樹脂 1540 により封止してパッケージとしたもので、半導体素子 1520 の電極パッド 1521 に対応する位置のインナーリード部 1512 を必要とするものであり、そして、このような装置封止型の半導体装置の製造工程として用いられる (本 図) リードフレームは、一面には図 15 (b) に示されるような構造のもので、半導体素子 1520 を搭載するためのダイパッド 1511 と、ダイパッド 1511 の周囲に設けられた半導体素子と接続するためのインナーリード部 1512、該インナーリード部 1512 に連結して外部図層との電気的接続を行うためのアフターリード部 1513、樹脂封止する際のダムとなるダムバー 1514、リードフレーム 1510 全体を支持するフレーム (本 図) 部 1515 を備えており、図 15 (b) (c) の 2 面を (42 x ニックル - 6 合金)、図 15 (b) のような構造に形成した金素を用い、プレス加工してエッチングにより形成されていた。図 15 (b) (c) の

に、図 15 (b) (d) に示すリードフレーム本装置の F1-F2 における断面図である。

(0 0 0 3) このようなリードフレームを形成した装置封止型の半導体装置 (プラスチックリードフレームパッケージ) において、電極部との電気的接続の構造と半導体素子の高集積化に伴い、小型高集積化かつ電極部との

に施したワイヤにより固定されており、該半導体素子の電極部はワイヤによりインナーリードの第1面と電気的に接続されていることを特徴とする装置封止型半導体装置。

(図 7) 図 1 ないし 2 において、半導体素子はバンプによりインナーリードの第2面に固定されて電気的にインナーリードと接続していることを特徴とする装置封止型半導体装置。

(図 8 の 別 開 示) 本 発 明 に、半導体装置の多ピン化に対応して、且つ、アフターリードの位置ずれ (スニュー) やアフターリードの半導体 (コプラチナチー) の変形を防ぐため、リードフレームを用いた装置封止型半導体装置に於ける。

(0 0 0 2)

(図 8 の 別 開 示) 従来の装置封止型の半導体装置 (プラスチックリードフレームパッケージ) は、一面に図 15 (a) に示されるような構造であり、

半導体素子 1510 を搭載するダイパッド部 1511 と、電極部との電気的接続を行うためのアフターリード部 1513、アフターリード部 1513 に一体となったインナーリード部 1512、該インナーリード部 1512 の先端部と半導体素子 1520 の電極パッド 1521 とを電気的に接続するためのワイヤ 1530、半導体素子 1520 を封止して外部からの応力、汚染から守る樹脂 1540 からなっており、半導体素子 1520 をリードフレームのダイパッド 1511 部に搭載した後、

に、樹脂 1540 により封止してパッケージとしたもので、半導体素子 1520 の電極パッド 1521 に対応する位置のインナーリード部 1512 を必要とするものであり、そして、このような装置封止型の半導体装置の製造工程として用いられる (本 図) リードフレームは、一面には図 15 (b) に示されるような構造のもので、半導体素子 1520 を搭載するためのダイパッド 1511 と、ダイパッド 1511 の周囲に設けられた半導体素子と接続するためのインナーリード部 1512、該インナーリード部 1512 に連結して外部図層との電気的接続を行うためのアフターリード部 1513、樹脂封止する際のダムとなるダムバー 1514、リードフレーム 1510 全体を支持するフレーム (本 図) 部 1515 を備えており、図 15 (b) (c) の 2 面を (42 x ニックル - 6 合金)、図 15 (b) のような構造に形成した金素を用い、プレス加工してエッチングにより形成されていた。図 15 (b) (c) の

に、図 15 (b) (d) に示すリードフレーム本装置の F1-F2 における断面図である。

(0 0 0 3) このようなリードフレームを形成した装置封止型の半導体装置 (プラスチックリードフレームパッケージ) において、電極部との電気的接続の構造と半導体素子の高集積化に伴い、小型高集積化かつ電極部との

て、テーピングの工程や、リードフレームを固定するクランプ工程で、ベタ法に似たような部分的に高くなった部分との段差が顕著になる場合があるので、エッチングを行うエリアはインターリード元端の裏面加工部分だけにせず全面にとる必要がある。ここで、温度57°C、比重4.8ボームの塩化銅溶液を用いて、スプレーで2.5 kg/cm²にて、レジストパターンが形成されたリードフレームSMH1110の両面をエッチングし、ベタ法（不足法）に似たような裏面の凹陥1150の部分をリードフレーム裏面の約2/3程度に達した時点でエッチングを止めた。（図11（b））

上図第1回目のエッチングにおいては、リードフレーム
は11110の面から同時にエッチングを行ったが、
必ずしも面から同時にエッチングする必要はない。本
実施例のように、第1回目のエッチングにおいてリード
フレームは11110の面から同時にエッチングする
理由は、面からエッチングすることにより、図2
第2回目のエッチング時間を短縮するため、レジスト
パターン9208面からの面エッチングの場合と
比べ、第1回目エッチングと第2回目エッチングのト
ータル時間が短縮される。言い、第一の面は1130
側の面とされた第一の面は150Uにエッチングを施し
1180としての副エッチングのあるホットメルト型

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MR-WB6)を、ダイコータを用いて、塗布し、ペタ
状(平造状)に塗布された第一の凹部1150に詰め込
んだ。レジストパターン1120A上にも同ニッティング液
を厚み1180に塗布された板とした。(図11
(c))

エッチングを済局 L180E、レジストパターン L12
-0A と全並に並行する強度はないが、第一の凹部 L15
0 を含む版にのみ露光することにより、

(c) に示すように、第一の凹部 1:50 とともに、第一の凹部 1:30 凹部にエッチング形成層 1:80 を形成した、エッチングで変化したニッチング凹部 1:80 は、アルカリ性溶液のワックスであるが、本発明に

エッチング液に耐性があり、エッチング時にある程度の腐食性のあるものが好ましく、特に、足反フックエッチング液として、U.V.硬化型のものでも良い。このようにエッチング液で、160マイナーリード先頭部の処理

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ス10目のエッチング加工にて作成された、リードフレーム面に示したエッチング抵抗面は既述であるが、この面を再び2面はインターリード部へこんだ状態である。次に、図9、エッチング抵抗層980のレジストパターン(レジストパターン1120A、1120B)の形成を行い、インターリード部131Aがエッチングされた図9(8)に示すリードフレーム130Aを形成した。エッチング抵抗層1180とレジストパターン1120A、1120B)の形成は既述のトリクル法処理により形成された。

(0014) 上記、図11に示すリードフレームの第2面には、本発明に用いられる、インターリード先端面を形成したリードフレームをエッチング加工により製造する方法で、特に、図1に示す、インターリード先端面の第1面131Aをエッチング処理の後の形状と同一面に、第2面131Bと方向を定めて形成し、且つ、第3面131A'と、第4面131A''をインターリードの内側に向かって傾んだ形状にするエッチング加工方法である。前述する本発明の第2面131Bにバンプを用いて半導体素子をインターリードの第2面131A'に形成し、インターリードと電気的に接続する場合に

—に、第2区1.3-1.Aをインターリード側に付込んだ見よ—
に取付した方がパンプ作動の際の許容圧が大くなる

図 12 に示すエッチング加工方法は、第 1 回目のエッチング工程までは、図 11 に示す方法と同じであるが、エッチング工程終了後、

第一の凹部1150側から第二凹部のエッチングを行い、其迄まで完成されている「電位」第一凹部のエッチングにて、第二凹部1140からのエッチングを更に続けていく。

図6(b)に示すように、異なる面より入射する光線がインターリード部にへこんだ凹部になる。

(0.015mm)

加工方法のように、エッチングと研磨に依つて行うエッチング加工方法も、一般には2段エッチング加工方法といっており、次第加工に有利な加工方法である。それ

えておくすると、図11(e)に示す、半導体W1を100 μ mとして、インターリード先端部ピッチcが0.15mmまで削減加工可能となる。距離1を300 μ m程度まで長くし、半導体W1を70 μ m程度とすると、インターリード先端部ピッチdが0.12mm程度まで加工加工ができるが、距離1、半導体W1のとり方次第ではインターリード先端部ピッチdに更に狭いピッチで加工が可能となる。ちなみに、インターリード先端部ピッチeを0.08mm、距離25 μ mで半導体40 μ m程度が範囲でとる。

(0016) このようにエッチング加工にてリードフ
レームを成型する時、インナーリードの長さが短かい場合
は、製造工程でインナーリードのヨレが発生しにくいが
場合には、図9(a)に示す状態のリードフレームエ
ッチング加工にて得るが、インナーリードの長さが長
く、インナーリードにヨレが発生し易い場合には、図9
(c)(イ)に示ように、インナーリード先端部から選
取部131Bを抜いて、インナーリード先端部を切断し
た状態にして成形したものを用いて、半導体装置に
必要な選択部131Bをプレス等により形成すること
で図9(a)に示す状態を得る。尚、前述のように、図9
(c)(イ)に示すものを切断し、図9(a)に示す状
態にする場合には、図9(c)(ロ)に示すように、選
取部131Bの長さの長さタイプ1500(ポリイミドタイプ)
を使用する。図9(c)(ロ)の状態で、プレス等によ
り選択部131Bを切断形成するが、半導体装置に、テ
ープをつけた状態のままで、リードフレームに固定さ
れる。その半導体装置が完成される。尚、図9(c)(イ)に示す
一切の部分を示すものである。

(0017) 本発明例の導電性層に用いられたリードフレームのインデニート系樹脂の断面形状は、図13(イ)に示すようになっており、ニッチング面を131Aとすると、W1には平面で反対側の面W2より若干大きくており、W1、W2(約100μm)ともこの部分の厚さを方向0度の面Wより大きくており、このようにインリーード先端部の断面に広がった断面形状であるため、どの方向においても導電性層(図示せず)とインナーリード先端部133とAとワイヤ127とA、1270Bによる密着(ボンディング)がし易いものとなっているが、本発明例の場合にはニッチング面側(図13(イ)の(a))をボンディング面としており、図13(イ)の131Aはニッチング面による断面、131Aはリードフレーム121の121A、121Bのつぎ面である。ニッチング面は面がアラビの無い面であるため、図13(ロ)の(a)の場合は、特に密着(ボンディング)密着が保たれる。図13(ハ)に図14に示す加工方法にて作製されたリードフレームのインナーリード先端部1331Bと導電性層(図示せず)との密着(ボンディング)を示すものであるが、この場合はインナーリード先端部1331B

の両面は正確ではあるが、この部分の両面両方の
ベスとくちない。また両面ともリードプレーニ
である。結局（ボンディング）面には正確な
ボンディング面より劣る。図13（二）にはプレス（ニ
ンク）によりインターリード面を形成した時に
ボンディング面によりインターリード面が1331C
1331Dを加えたものの、ニッケル（S）面
との面（ボンディング）を示したものであるが、こ
れをプレス面が図に示すようにニッケル（S）
のため、どちらの面を用いて面（ボンディング）し
ても、図11（二）の（a）、（b）に示すように面
（ボンディング）の面に正確な面が速く形成される
なる場合が多い。図1321A Bはボンディング面と

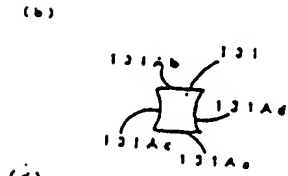
(0018) 次に実施例1の導波路止型半導体装置の実例を挙げる。図3(a)~図3(c)に、それぞれ、実施例1の導波路止型半導体装置の実例の断面図である。図3(a)に示す実施例の半導体装置は、実施例1の半導体装置とは、ダイバッド135の図像が異なるもので、ダイバッド135が外周に露出している。ダイバッド135が外周に露出していることにより、実施例1に比べ、熱の発散性が保れている。図3(b)に示す実施例の半導体装置も、ダイバッド135が外周に露出させているものであり、実施例1に比べ、熱の発散性が保れている。実施例1や図3(a)に示す実施例とは、半導体シリコンの肉厚が異なり、ワイヤボンディング面をリードフレームの裏面に付けている。図3(c)~図3(d)・図3(e)に示す実施例は、それぞれ実施例1、図3(a)に示す実施例、図3(b)に示す実施例において、半導体の表面からなる導波路を覆わず、導波路の面を底層導波路として用いているものであり、前述二例を応用した構造となっている。

(0019) において、系列2の車止止面は車止面
を指す。図4(a)に系列2の車止止面とは二
つの新面であり、図4(b)に面4、5との入角面、
4におけるインナーリード面の新面図で、図4(c)は
図4(a)のB3-B4における端子断面の新面図であ
る。尚、系列2の車止面は面の外側に系列1とは二
つ同じとなる系止面に寄与した。面210は車止面
面、210は車止面、211は車止面(パッ
ド)、220はワイヤ、330はリードフレーム、23
0はインターリード、231Aは第1面、232Aは第
2面、231Acは第3面、231Adは第4面、
233は端子断面、233Aは端子部、233Bは第
5面、233Cは上表面、240は止面、270は
有線固定用タイプある。系列2の車止面は面にお
いては、リードフレーム230はダイパッドを用いたこ
の、車止面は端子210はインターリード231ととし
て有線固定用タイプ270により固定されており、車
止面は端子210、車止面は端子の面(パッド)211

2番から、図7(a)には第6Aの第11止点である
第8の断面であり、図7(b)に図7(a)のA7-
8におけるインターリード部の断面、図6(c)に
図6(a)の67-98における第E部の断面であ
る。図7は、第6Aの第11止点の位置が第8とほぼ
同じとなる。図に示した、図7c、400には第
2部、410には第3部、411にはパッド、430に

190	ードフレーム面	
260	1331入b	
270	イニグ面	
270	1410	
270	ードフレーム面	
270	1420	
270	オトレジスト	
270	1430	
270	ジストバターン	
270	1440	
270	ンターリード	
270	1510	
270	ードフレーム	
270	1511	
270	イパッド	
270	1512	
270	ンターリード	
270	1512入	
270	ンターリード先列	
270	1513	
270	ワターリード	
270	1514	
270	ムバー	
270	1515	
270	レーム面 (内面)	
270	1520	
270	面体表示	
270	1521	
270	面体 (パッド)	
270	1530	
270	1540	
270	止用面	

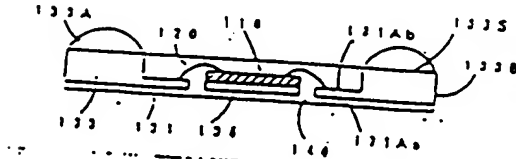
(۱)



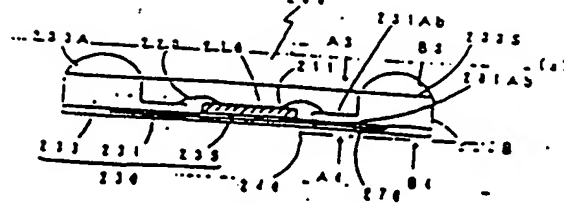
(5)



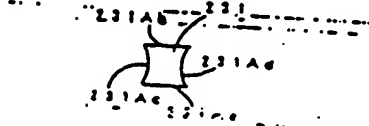
(८)



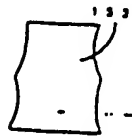
(۱)



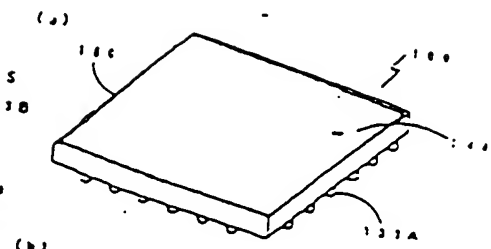
(2)



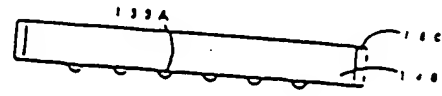
(c)



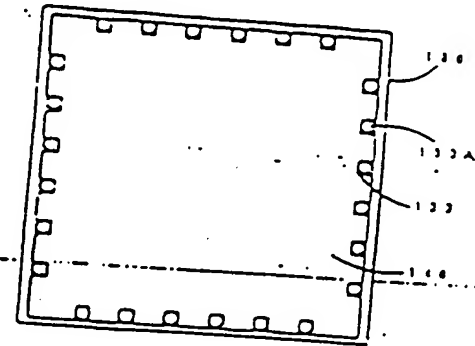
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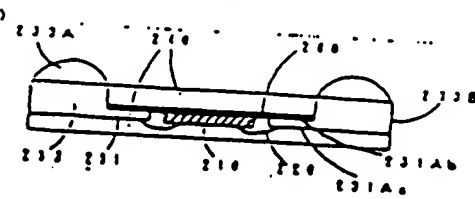
(02)



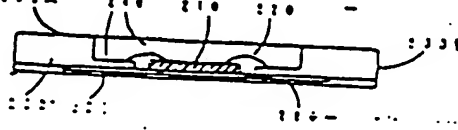
(c)



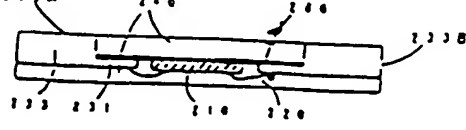
(25)



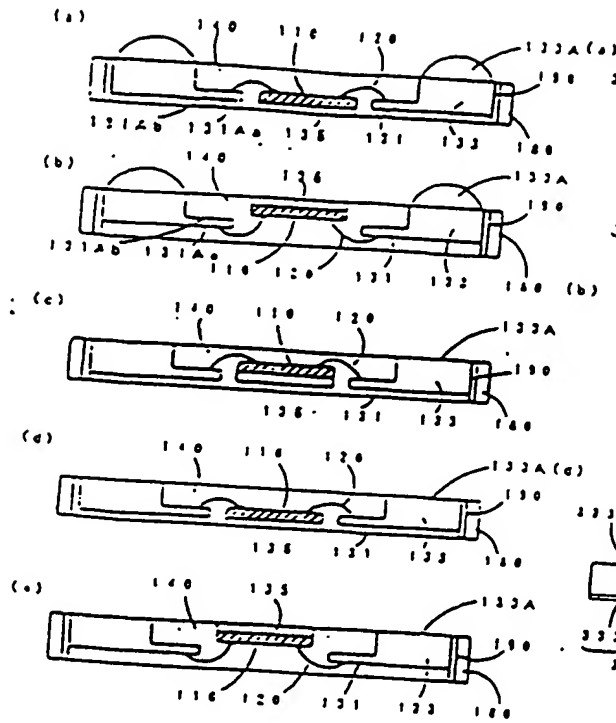
(4)



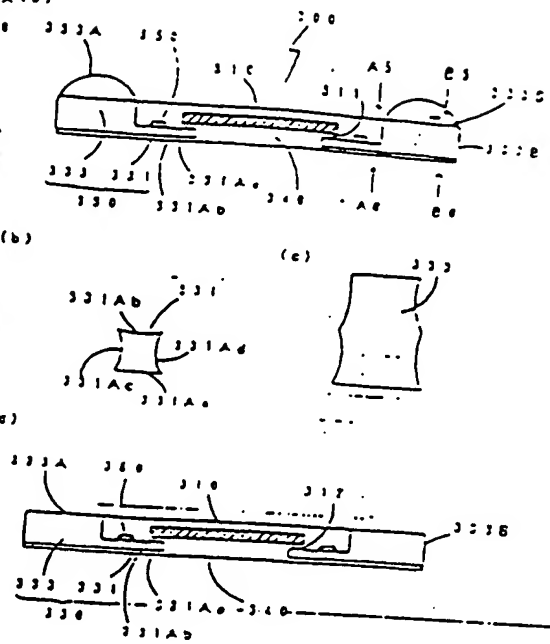
(c)



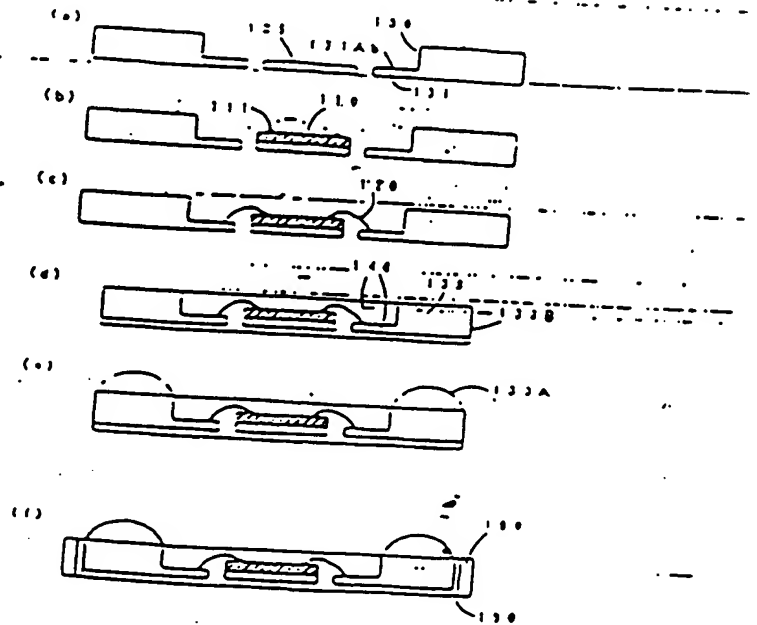
(23)



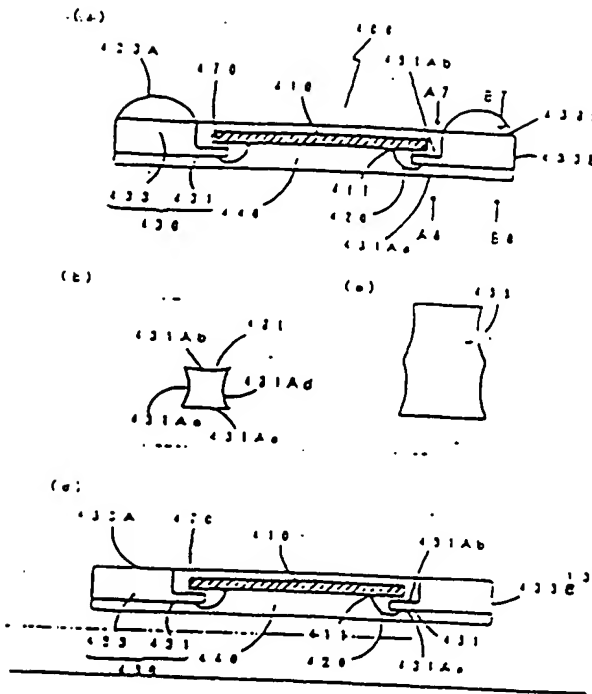
(26)



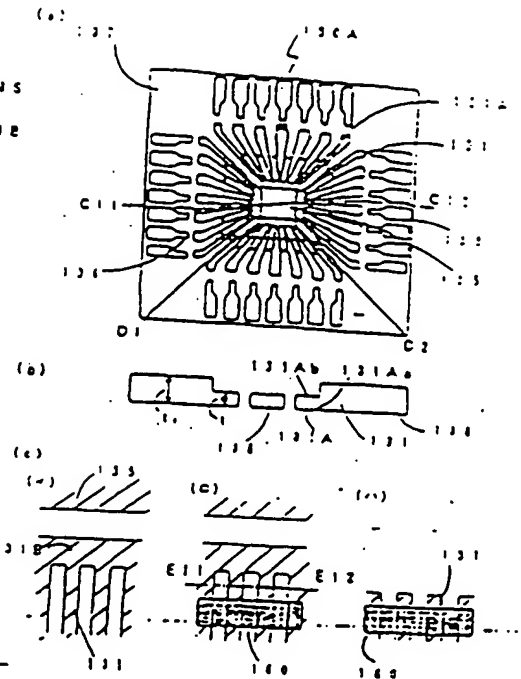
(29)



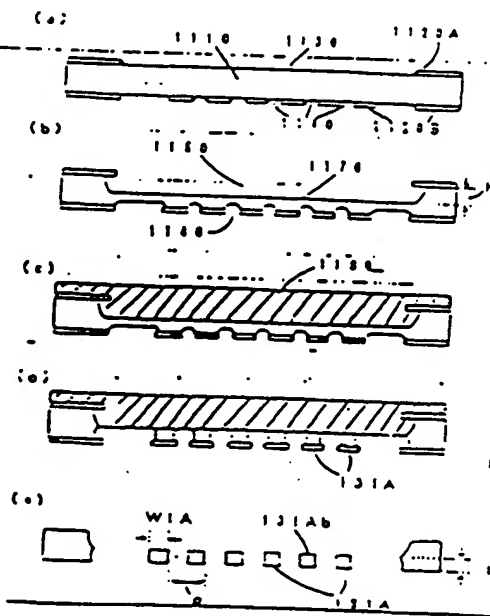
(27)



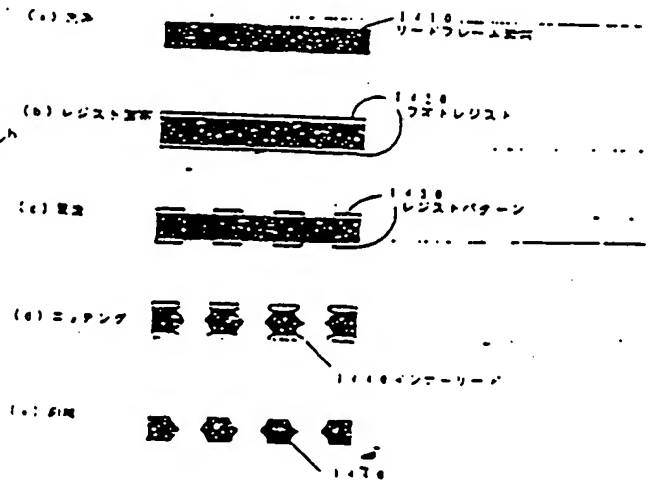
(28)



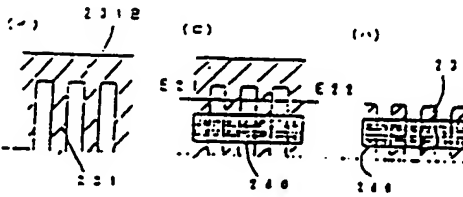
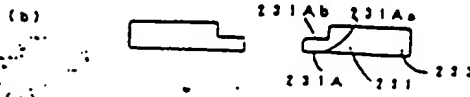
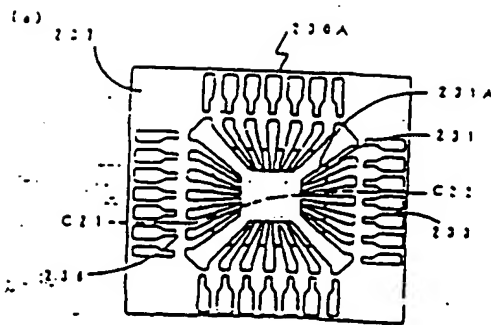
(29)



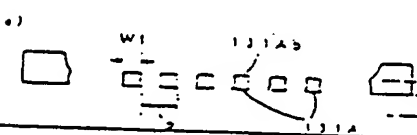
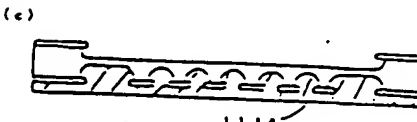
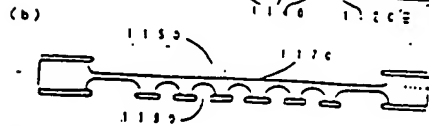
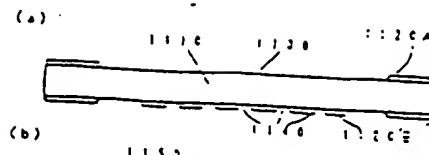
(30)



(210)



(212)



(215)

